WASTE TREATMENT ALTERNATIVES
FOR
THE VILLAGE OF TAVISTOCK

December, 1977

Ministry
of the
Environment

Ontario

WASTE TREATMENT ALTERNATIVES

FOR

THE VILLAGE OF TAVISTOCK

Water Resources Assessment Unit
Technical Support Section
Southwestern Region

Ministry of the Environment December, 1977

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SUMMARY AND RECOMMENDATIONS

Four sewage treatment options are advanced in this report for the Village of Tavistock that should adequately protect the Thames River (and its water uses) for a design sewage flow of 0.336 million Imperial gallons per day (to serve a population increase to 2800 persons at 120 Imperial gallons per capita per day of sewage flow).

The addition of a mechanical plant to the existing lagoon or the development of an aerated lagoon system, both of which are based on discharge to streamflow during the period November to April, should adequately protect water quality in the Thames River. However, with these options, further assessment of lagoon operations and stream quality may demonstrate the ultimate need for a pipeline to the main branch of the Thames River to offset sub-lethal effects of ammonia on warm-water biota in the un-named tributary receiving the treated effluent. Another option, involving a lagoon system coupled with spray irrigation, can be considered without qualification. A final option, employing non-aerated lagoons, would require the utilization of a pipeline to the main branch of the Thames River to accommodate the sewage flow associated with the projected increase in population.

The following recommendations are advanced:

1. There should be no discharge of sewage effluent to the Thames River for the period from April 16 to October 31.

2. The four sewage treatment options outlined in this report should be investigated using the requirements for sewage effluent quality and the discharge to streamflow ratios which are provided. The most feasible option should be chosen.

INTRODUCTION

Information obtained from the Municipal and Private Abatement Section indicates that the lagoons at the Village of Tavistock have reached hydraulic capacity. Therefore, the Council of the Village of Tavistock and staff of the Municipal and Private Abatement Section have requested that viable waste treatment alternatives be outlined together with appropriate design data to provide expansion to a population of 2800. This report recommends waste treatment alternatives that should be investigated by the Village.

BASIN DESCRIPTION

Figure 1 shows the location of the Village of Tavistock and its lagoons in relation to the Thames River from its source to the Gordon Pittock Reservoir. This reach of the Thames River flows through the Oxford Till (clay) plain physiographic unit. The lagoons are discharged twice annually (spring and fall) into an un-named tributary approximately 1¼ mile from the Thames channel. The area of the Thames River watershed above the entry point for discharge from the Tavistock lagoons is 16.6 square miles and the average gradient in this reach is 28 feet per mile. The drainage area of the tributary which receives the lagoon discharge is about 1.8 square miles. The Village of Tavistock is located approximately 20 miles up-river from the Gordon Pittock Reservoir and the Thames has an average gradient of 7.5 feet per mile in this reach.

WATER USE

Water uses in the upper reaches of the Thames River near Tavistock include livestock watering, sport

fishing and waste assimilation. Below the Tavistock sewage lagoons the river is used to assimilate sewage effluent and for livestock watering.

There are sport fish such as bass and pike in the Thames River above the Gordon Pittock Reservoir near Tavistock. During a fish sampling survey upstream of Innerkip on the Thames River on July 27, 1977, several largemouth bass, smallmouth bass and perch were identified. Extensive fishing occurs in the Gordon Pittock Reservoir for pike and other sport fish and local residents fish the river upstream of the reservoir.

WASTE TREATMENT FACILITIES

The waste treatment system for the Village of Tavistock consists of a 2-celled, 32-acre, waste-stabilization pond system. This system, as constructed in 1962, was designed for continuous discharge but was converted to operate on a seasonal discharge (spring and fall discharge) basis in 1967 for the protection of water quality in the stream. The hydraulic capacity for this method of operation is 242,000 Imperial gallons per day (Igpd). In 1972, the flows were about 165,000 Igpd. With the installation of a separated storm sewer in 1974, the flows were reduced to about 145,000 Igpd. By 1976, however, flows had increased to 180,000 Igpd requiring expansion of the system before hydraulic overloading occurs.

HYDROLOGY

During the summer of 1976, a weir and continuous flow measuring equipment were installed to determine streamflows at Tavistock (Figure 2). It was found that flows were

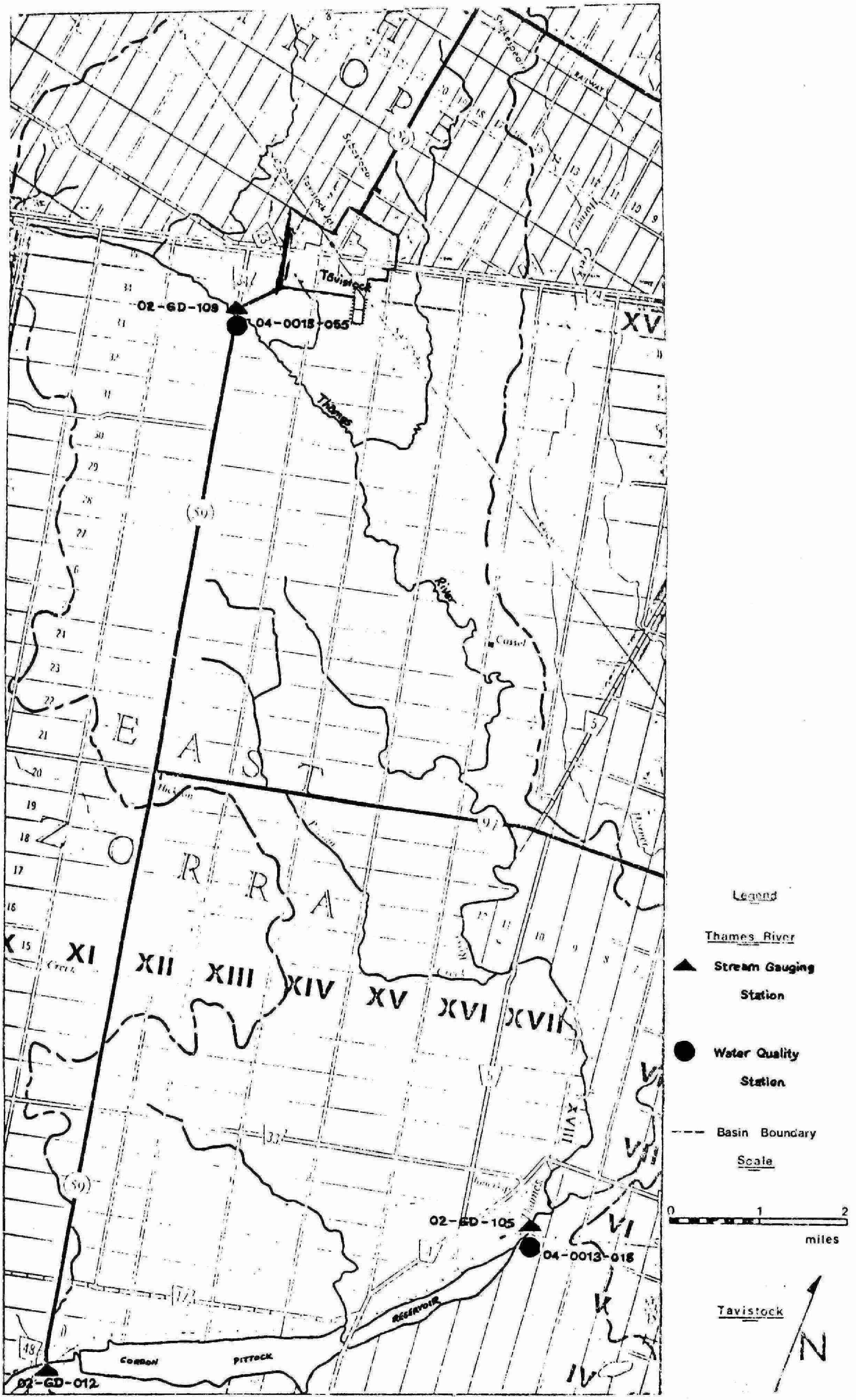

FIGURE 1 Thames River Basin in the vicinity of Tavistock

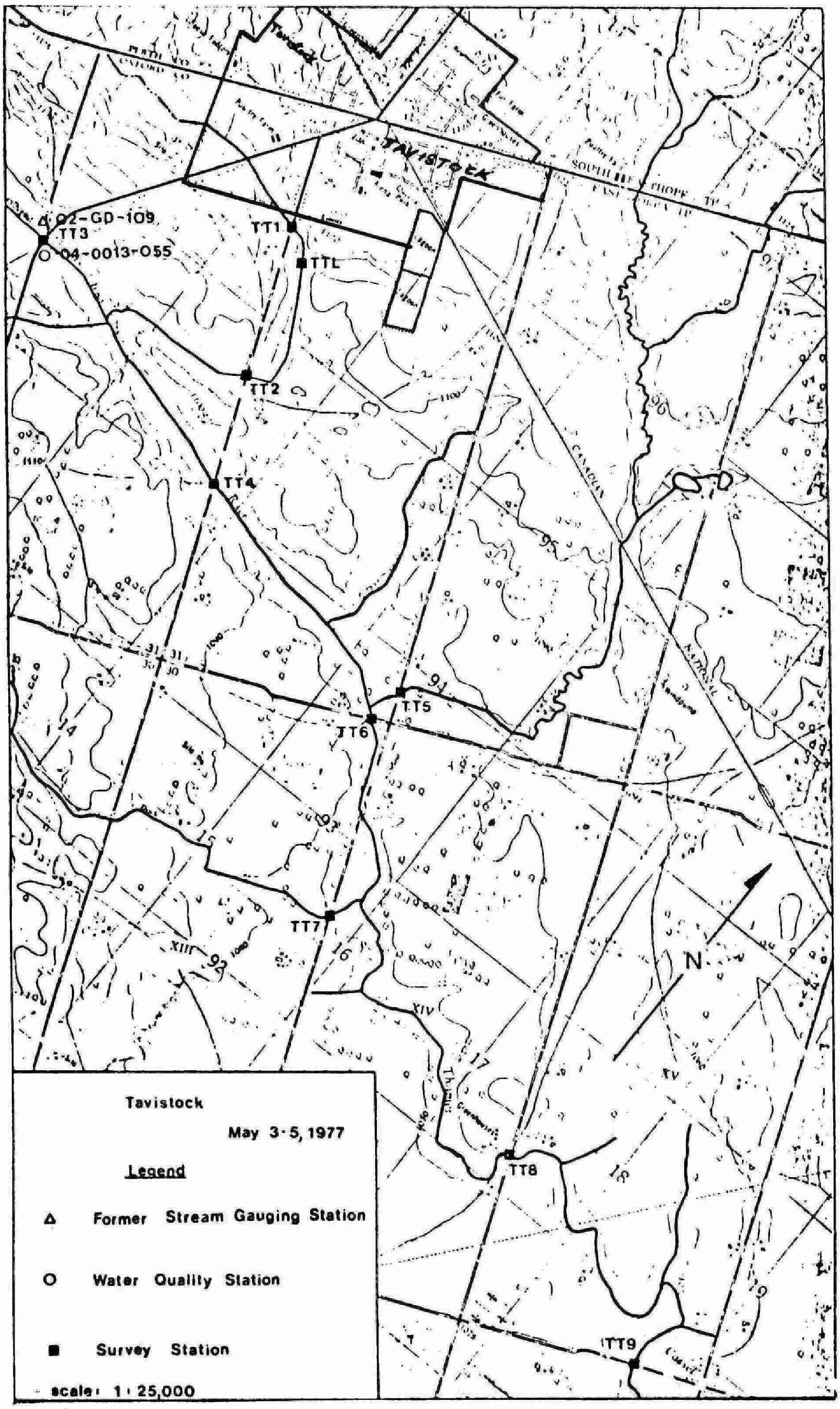

Figure 2 Survey stations on the Thames River, May 3-5, 1977

often less than 1.0 cfs in June, July and September. Mean monthly flows and minimum monthly average flows with a recurrence interval of 1 in 10 years for the federal stream gauge on Trout Creek (No. 02GD019) pro-rated to the Thames River at Tavistock are presented in Table 1.

The minimum monthly average flows with a recurrence interval of 1 in 10 years are to be used for design instead of the usual 1 in 20 year interval since stream gauging data are not available for the 20 year period. We hesitate to extend the 10 years of record to obtain projected 20 year values, especially since the data are pro-rated; however, it is considered that the 1 in 10 year monthly minima are more extreme than those flows which would have occurred sequentially in any given year for the November to April period in the 10 years of record.

Streamflows measured at the time of the intensive survey from May 3 to May 5, 1977 are shown in Table 2. There was virtually no dilution of sewage effluent in the tributary of the Thames River at the outfall from the sewage lagoons during the survey. At the junction of the tributary with the Thames River, there was approximately a 1:1 dilution of sewage effluent with streamflow.

WATER QUALITY

Water quality data are available at two long-term monitoring stations (04-0013-018-02 at Innerkip and 04-0013-0055-02 upstream of the lagoon discharge) (Figure 1). A summary of the data collected from the long-term station at Innerkip is contained in Table A1 of Appendix A. These data show acceptable levels of dissolved oxygen at the time of sampling. The annual average BOD_5 concentrations ranged from 1 to 3 milligrams per litre (mg/l) with maximum levels

Table 1 - Streamflow Data for the Thames River near Tavistock at the Junction of the Un-named Tributary which Receives the Discharge from the Lagoons.

Month	Mean Monthly Flow (cfs)	Minimum Monthly Average Flow with a Recurrence of 1 in 10 Years (cfs)
January	27.0	4
February	23.9	4
March	65.2	35
April	63.7	16
May	15.4	5
June	8.4	0.7*
July	2.6	0.4*
August	2.0	0.1*
September	2.5	0.1*
October	7.3	0.3*
November	20.3	2
December	26.8	2

* Low flows were calculated by multiplying flows from Trout Creek (period of record 1967-1975) by 0.39 based on data collected at the Tavistock station while other flows were prorated on an area basis.

Drainage Area of Thames River above point of effluent discharge = 16.6 square miles

Drainage Area of Trout Creek above Federal Gauge 02GD019 = 13.9 square miles.

Table 2 - Streamflows During the 1977 Survey in the Thames River at Tavistock

Station	Date	Streamflow (cfs)
TT1	May 4, 1977	0.41
	May 5, 1977	0.35
	Average	0.38
TT2	May 4, 1977	6.16
	May 5, 1977	5.33
	Average	5.75
TT3	May 4, 1977	3.35
TT4	May 5, 1977	9.11

Lagoon flow = TT2 - TT1 = 5.75 - 0.38 = 5.37 cfs.

as high as 10 mg/l during spring runoff. (The samples collected 4 days after the termination of the intensive survey (May 3 to 5) exhibited a BOD_5 of 13 mg/l). The annual average total phosphorus levels have, for the most part, been in excess of the desirable range of 0.02 to 0.06 mg/l (to avoid excessive aquatic plant growth). Annual average total free ammonia concentrations ranged from 0.05 mg/l to 0.19 mg/l and total Kjeldahl nitrogen (TKN)ranged from 0.73 mg/l to 1.1 mg/l. The bacteriological data indicate that the levels in the river at that station are consistently in excess of this Ministry's criteria for livestock watering, body-contact recreation and irrigation.

Data obtained from a survey of water quality during the period May 3 to 5, 1977 are presented in Table B and Figure B1 to B6 of Appendix I. Locations of the stations sampled are shown in Figure 2. Bacteriological analyses (geometric means) indicate that this Ministry's criteria for livestock watering, irrigation and body-contact recreation were exceeded both upstream and downstream of the discharge from the lagoon. Minimum dissolved oxygen concentrations in the Thames River below the effluent discharge did not fall below 6 mg/l for the first 5 miles downstream even though the BOD_5 (25 mg/l) and total Kjeldahl nitrogen (10 mg/l) were typical of lagoon effluents and the dilution ratio was only 1:1.

The ammonia levels in the Tavistock effluent (average 5.9 mg/l during the survey) resulted in toxic concentrations of ammonia (greater than 0.3 mg/l, unionized) to warm water fish in the 1¼ mile tributary of the Thames River. Downstream of the junction of the tributary with the Thames River, levels of unionized ammonia persisted above the sublethal value of 0.03 mg/l for about 5 miles.

WATER QUALITY IN RELATION TO DESIGN CRITERIA

Several options have been identified for the expansion of sewage treatment facilities at Tavistock. These include:

1. The existing lagoon in conjunction with a sewage treatment plant as outlined in the Thames River Basin Water Management study.

2. Lagoons with spray irrigation of sewage effluent.

3. Aerated lagoons and discharge to streamflow in the period from November to April.

4. Non-aerated lagoons and discharge to streamflow in the period from November to April with a pipeline to the main Thames River.

From an analysis of streamflow data, there are low flows in the summer months which annually approach or achieve zero. Because of these low flows, a year-round discharge from any treatment system is not a viable option and the treatment system must include lagoons. Any expansion of sewage facilities must permit no discharge of effluent during the May to October period because of phosphorus loadings and oxygen-demanding materials in the effluent. The streamflow values for the Thames River at Tavistock to be used for the design of the lagoons for the period from November to April are given in Table 3.

Table 3 - Design Streamflows for the Thames River at Tavistock

Month	Minimum Monthly Average Streamflow with a Return Period of 1 in 10 Years (cfs)
November	2
December	2
January	4
February	4
March	35
April	16

The following key criteria are considered to be valid objectives for the protection of aquatic life in the Thames River:

1. Dissolved oxygen values should be above 5 mg/l.

2. Unionized ammonia should not exceed the estimated sublethal value of 0.03 mg/l for warm-water biota for extended periods. (NOTE: the background total free ammonia in the stream above the existing lagoon outfall in the winter is estimated at times as high as 0.4 mg/l). The ratio of unionizied to free ammonia varies substantially with pH and temperature.

Options 1 and 2

For option 1, winter discharge from a secondary mechanical sewage treatment plant is reasoned to have an ammonia loading of 5 mg/l since nitrification is very low at low temperatures. Therefore, the dilution ratios required for lagoons with aeration are similar to those that would be required for a mechanical plant. With the above information and information contained in the Thames River Basin Water Management Study, options 1 and 2 can be evaluated.

Options 3 and 4

In order to assess the feasibility of options 3 and 4 (involving modifications to the existing lagoons and modes of operation) it has been necessary to evaluate assumed effluent quality in relation to the minimum monthly average streamflows presented in Table 1. With respect to option 3, the assumption is made that free ammonia levels from the

lagoons during winter periods would be significantly reduced through an aeration process to keep the lagoons ice-free and/or an aeration cell for the final effluent. (As limited information is available on ammonia levels in lagoon discharges, particularly during winter periods, it is our intention to evaluate ammonia build-up in relation to the presence of ice cover at Tavistock during the 1977-78 winter season). Conditions and considerations that have been taken into account for options 3 and 4 are as follows:

Option 3, Lagoons with aeration

Aeration would be coupled with an expansion of lagoon area or the existing lagoons would be deepened with mixing and aeration. Effluent criteria for lagoons with aeration are as follows:

BOD_5	30 mg/l
Suspended Solids	30 mg/l
TKN	10 mg/l
Total Phosphorus	< 1 mg/l, <0.5 mg/l preferred
Minimum Dissolved oxygen	3 mg/l, 5 mg/l preferred
Free Ammonia as N	5 mg/l
pH	< 8

For option 3, the following operational conditions would have to apply:

1. No discharge of effluent from April 16 to October 31.

2. Continuous phosphorus removal for 12 months of the year to reduce phosphorus in the effluent to a maximum of 1 mg/l and preferably to 0.5 mg/l or less.

3. Discharge of sewage effluent in proportion to streamflow in the November to April period as specified on page 10.

4. In the period from November 1 to March 1, effluent should be discharged at a rate less than 3 times the daily influent value and also in such a way that the lagoon would contain at least 4 feet of effluent on March 1 (also observing the dilution requirements).

5. Calculated effluent values for ammonia are based on the assumption that the lagoons will be loaded (on the average) at a rate no greater than 20 pounds of BOD_5 per acre per day.

In assessing the feasibility of option 3, it has been assumed that the pH in the stream during the winter months would be equal to or less than 8, that dissolved oxygen in the stream above the outfall would at times be less than 60% of saturation (based on some field observations) and that stream temperatures during the winter period are as follows:

November	$10^{\circ}C$
December to February	$5^{\circ}C$
March	$10^{\circ}C$
April	$15^{\circ}C$

Calculated ratios for minimum streamflow to lagoon effluent to maintain adequate water quality using an aerated lagoon are as follows:

Month	Minimum Dilution Ratios of Streamflow to Lagoon Effluent*
November	3:1
December	1.5:1
January	1.5:1
February	1.5:1
March	3:1
April	5.5:1

* It is essential that the minimum dissolved oxygen in the effluent be maintained at 3 mg/l or greater.

Option 4, Lagoons without aeration

Another option is one in which the lagoon is not aerated. In this case, different effluent criteria and ratios of streamflow to effluent must be applied. The following effluent criteria for lagoons without aeration are:

BOD_5	30 mg/l
Suspended Solids	30 mg/l
TKN	15 mg/l
Total Phosphorus	<1 mg/l, <0.5 mg/l preferred
Minimum Dissolved oxygen	0 mg/l, 5 mg/l preferred
Free Ammonia as N	12 mg/l
pH	< 8

For option 4, the same operational conditions which are outlined for option 3 apply. To meet these criteria the following dilution ratios would have to apply to lagoons which are not aerated:

Month	Minimum Dilution Ratios of Streamflow to Lagoon Effluent
November	8.5:1
December	5:1
January	5:1
February	5:1
March	8.5:1
April	15:1

DISCUSSION

Options 1 and 3 will be considered at this time without a pipeline to the main Thames River because information on pH and ammonia from lagoons and the corresponding criteria for the protection of warm water biota are not completely finalized. A pipeline to the main Thames River for these options will be required for a population equivalent of 2,800 or 0.336 million Imperial gallons per day and may be required for a lesser population if studies show that production of warm water biota in the un-named tributary is significantly affected.

Similarily, option 4 would require aeration of the lagoon final effluent for a population equivalent of greater than 2,800 (0.336 million Imperial gallons per day).

From the requirements, conditions and information set out in this report, it is felt that the several options for sewage treatment can be investigated and one which is most feasible in relation to providing the necessary protection for the Thames River at minimum cost can be determined.

Appendix I

Water Quality Data

Station	Dissolved Oxygen Ave	Dissolved Oxygen Max	Dissolved Oxygen Min	C° Temp	BOD5 Ave	BOD5 Max	BOD5 Min	Phosphorus Total Ave	Phosphorus Total Max	Phosphorus Total Min	Phosphorus Sol	Nitrogen FA	Nitrogen Kjel Ave	Nitrogen Kjel Max	Nitrogen Kjel Min	Nitrogen NO_2	Nitrogen NO_3	Cl
1970	9.3	12.0	7.5	8.5	1	2	1	0.054	0.110	0.018	0.032	0.11	0.74	0.98	0.51	0.031	3.4	26
1971	8.0	11.0	4.0	10.4	2	4	1	0.047	0.120	0.018	0.020	0.19	0.73	4.70	0.30	0.025	2.2	23
1972	9.3	13.8	5.3	10.5	2	5	1	0.133	0.340	0.034	0.051	0.17	1.1	2.00	0.69	0.047	3.6	35
1973	10.4	13.3	6.8	12.7	2	8	1	0.107	0.440	0.042	0.048	0.19	0.99	3.40	0.55	0.053	2.6	25
1974	10.5	12.6	7.6	8.6	1	2	1	0.057	0.140	0.024	0.020	0.05	0.74	2.20	0.50	0.037	3.8	28.5
1975	14.1	17.2	11.9	11.2	3	10	1	0.304	2.3	0.006	0.052	0.18	0.94	3.2	0.445	0.022	2.6	30
1976	12.3	15.8	10.3	10.6	2	8	0	0.092	0.345	0.020	0.038	0.068	0.792	1.73	0.420	0.051	4.0	27.4

TABLE A1 - Water quality data at long term station 04-0013-018-02

NOTE: All results in mg/l except where indicated

Station	Bacteria /100 ml				Solids													
	T C	F C	F S	P A	Total	Susp												

Station	Bacteria /100 ml				Solids	
	T C	F C	F S	P A	Total	Susp
1970	211					
1971	350					
1972	2,059	258	242			
1973	3,634	521	441			
1974	848	184	145			
1975	959	206	192			
1976	2,650	212	356			

TABLE A1 - (Cont'd)

Sampling Period......to.......

[illegible]ream..................

Reach..............

Monitoring Summary Card

Station	Dissolved Oxygen			C^{o} Temp	BOD_5			Phosphorus				Nitrogen					
								Total			Sol	FA	Kjel			NO_2	NO_3
	Ave	Max	Min		Ave	Max	Min	Ave	Max	Min			Ave	Max	Min		

DATE 1976	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				Cond.	Turb.	Chlorides	SOLIDS		PSA
				Total	Fecal	Strep.	Total	Sol	F. A	Kjel.	Nitrite	Nitrate				Tot.	Susp.	
Sept. 21	11.3	15.0	2										600	7.6		380	8.0	
Oct. 21	9.9	7.3	2	15,000	840	3,800	0.091	0.051	0.190	1.15	0.031	1.13	650	2.4	15.0	386	3.5	28
Nov. 24	---	1.2	2	190	20	<4	0.041	0.019	0.015	0.530	0.010	1.65	620	3.7	13.5	430	<15	<4
Dec. 15	13.2	0.2	1	2,200	112	537	0.051	0.023	0.155	0.655	0.017	2.4	670	4.0	13.0	400	7.5	<4
1977 Mar. 15	10.1	4.5	2	960	120	480	0.160	0.071	0.195	1.10	0.042	4.2	360	16	9.5	276	31	4
Apr. 12	11.4	14.0	1	780	36	32	0.046	0.019	0.080	0.625	0.026	3.22	520	4.7	15.0	336	<15	<4
May 9			1	600	12	20	0.030	0.009	0.025	0.625	0.021	1.46	540	2.9	13.0	286	<15	<4
June 20			2	2,400	716	68	0.088	0.029	0.100	0.890	0.032	0.28	520	4.4	12.5	324	7.5	<4
July 20			2	2,100	740	140	0.185	0.039	0.025	0.875	0.041	0.17	530	3.8	12.5	304	17	<4
Aug. 15			2	3,100	536	128	0.106	0.047	0.025	0.720	0.012	0.06	502	5.0	11.0	318	10	<4
Sept. 19			1	51,000	2,800	1,000	0.264	0.169	0.115	1.39	0.093	5.90	565	24	17.5	422	23	60
Oct. 17			0	2,200	30	100	0.076	0.056	0.035	0.650	0.027	3.7	615	6.7	14.0	424	<15	<4
					GEOM. MEAN												GEOM.	MEAN
	AVGE.		1.5	2,167	164	136	0.095	0.044	0.080	0.768	0.029	2.01	515	6.6	12.2	330	<12.3	2
	MAX.		2	51,000	2,800	1,000	0.264	0.169	0.195	1.39	0.093	5.90	670	24	17.5	430	31	60
	MIN.		0	190	12	<4	0.030	0.009	0.015	0.530	0.010	0.06	360	2.4	9.5	276	7.5	<4

TABLE A2 - Water quality data at long term station 04-0013-055-02

Ministry of the Environment
Ontario

Monitor Data Card

Stream.................................... Station............................ Description...

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens									
				Total	Fecal	Strep.	Total	Sol	F. A.	Kjel.	Nitrite	Nitrate						

Station	Dissolved Oxygen Ave	Max	Min	C° Temp	BOD5 Ave	Max	Min	Phosphorus Total Ave	Max	Min	Sol	Nitrogen FA	kjel Ave	Max	Min	NO_2	NO_3
T-T-3	10.5	14.8	7.8	11.7	2	2	1	0.038	0.046	0.029	0.009	0.038	0.644	0.715	0.570	0.024	2.2
T-T-1	10.8	16.0	5.6	11.2	2	3	1	0.096	0.113	0.088	0.038	0.048	0.617	0.700	0.485	0.027	0.98
T-T-L	12.4	15.8	10.7	12.9	26	37	18	1.65	1.73	1.57	0.56	5.9	13.1	14.8	7.50	0.026	0.15
T-T-2	11.9	17.0	6.3	12.4	25	30	16	1.61	1.80	1.46	0.53	5.7	13.1	15.5	10.1	0.037	0.20
T-T-4	12.2	19.7	7.6	12.0	17	24	9	0.78	0.880	0.55	0.29	2.9	7.84	8.50	7.40	0.043	1.22
T-T-5	11.6	17.6	7.4	10.9	3	3	1	0.051	0.061	0.042	0.008	0.025	0.588	0.740	0.475	0.054	1.9
T-T-6	12.7	>20	7.0	11.5	14	18	8	0.584	0.630	0.505	0.151	1.7	5.36	6.70	4.72	0.053	1.38
T-T-7	11.5	18.0	6.4	10.3	3	4	2	0.177	0.507	0.028	0.019	0.021	0.479	0.745	0.305	0.081	7.4
T-T-8	14.6	>20	8.9	12.2	17	24	10	0.463	0.58	0.345	0.057	0.864	4.75	5.55	3.60	0.059	1.8
T-T-9	14.4	>20	9.5	11.8	15	22	12	0.473	0.545	0.410	0.031	0.808	4.41	5.05	4.12	0.062	1.9

TABLE B1 - Water quality data from survey, May 3-5, 1977

NOTE: All results in mg/l except where indicated

Station	Bacteria /100 ml				Solids		T.O.C.	Inrg. Carbon	Total Carbon	Cond	pH	Cl	Turb.	Diss. Solids
	T C	F C	F S	P A	Total	Susp								
T-T-3	845	318	139	1	329	8	9	53	62	523	7.92	13.8	3.4	
T-T-1	119559	882	220	3	434	16	7	62	69	717	8.30	57	6.7	
T-T-L	84,926	2,339	116	39	717	65.5	35	56	91	1,143	8.58	164	13.3	
T-T-2	114869	2,282	684	36	707	81	34	57	91	1,110	8.52	155	15.3	
T-T-4	27,441	865	268	7	525	50	22	54	77	827	8.52	83	12.0	
T-T-5	3,518	211	334	2	396	13	6	44	50.0	603	8.35	43	5.1	
T-T-6	13,581	467	238	10	505	45	16.5	51.4	68	770	8.57	77	12.8	
T-T-7	3,026	92	265	2	431	11.5	5	49	54	653	8.16	43.8	4.1	
T-T-8	13,774	519	398	3	485	53	18	48	66.5	730	8.39	72	16.3	422
T-T-9	12,508	250	193	4	524	52	19	45	64	767	8.37	73	16.3	467

Station	Bacteria /100 ml				Solids		T.O.C.	Inrg. Carbon	Total Carbon	Cond.	pH	Cl	Turb.	Diss. Solids
	TC	FC	FS	PA	Total	Susp								
T-T-3	845	318	139	1	329	8	9	53	62	523	7.92	13.8	3.4	
T-T-1	119559	882	220	3	434	16	7	62	69	717	8.30	57	6.7	
T-T-L	84,926	2,339	116	39	717	65.5	35	56	91	1,143	8.58	164	13.3	
T-T-2	114869	2,282	684	36	707	81	34	57	91	1,110	8.52	155	15.3	
T-T-4	27,441	865	268	7	525	50	22	54	77	827	8.52	83	12.0	
T-T-5	3,518	211	334	2	396	13	6	44	50.0	603	8.35	43	5.1	
T-T-6	13,581	467	238	10	505	45	16.5	51.4	68	770	8.57	77	12.8	
T-T-7	3,026	92	265	2	431	11.5	5	49	54	653	8.16	43.8	4.1	
T-T-8	13,774	519	398	3	485	53	18	48	66.5	730	8.39	72	16.3	422
T-T-9	12,508	250	193	4	524	52	19	45	64	767	8.37	73	16.3	467

TABLE B1 - (Cont'd)

Sampling Period ...... to ....

Stream ....

Reach ....

Monitoring Summary Card

Station	Dissolved Oxygen			C° Temp	BOD_5			Phosphorus				Nitrogen					
								Total			Sol	FA	kjel			NO_2	NO_3
	Ave	Max	Min		Ave	Max	Min	Ave	Max	Min			Ave	Max	Min		

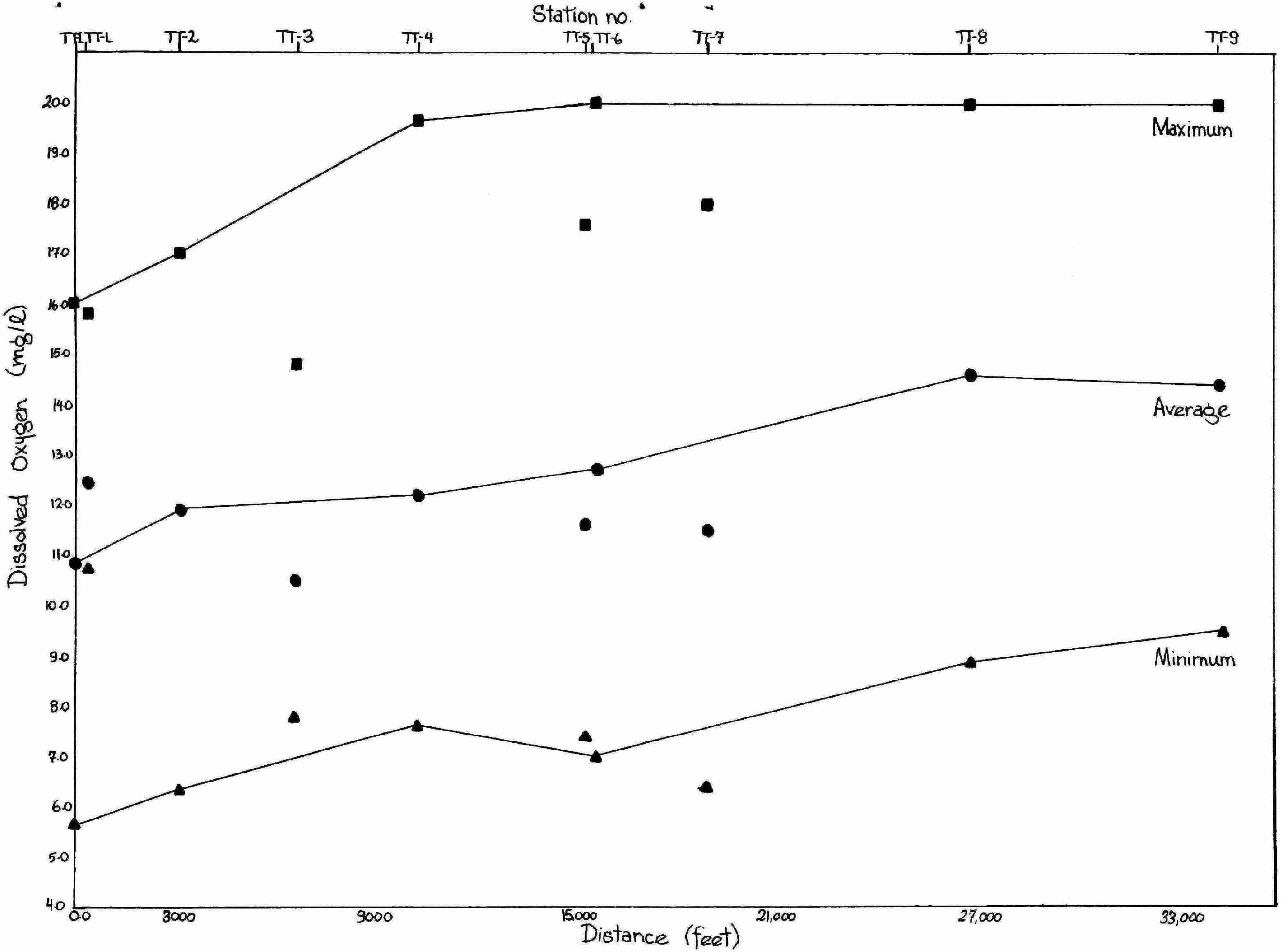

Figure B1 Dissolved Oxygen vs. Distance for stations shown on the North Thames River around Tavistock 3-5 May 1977

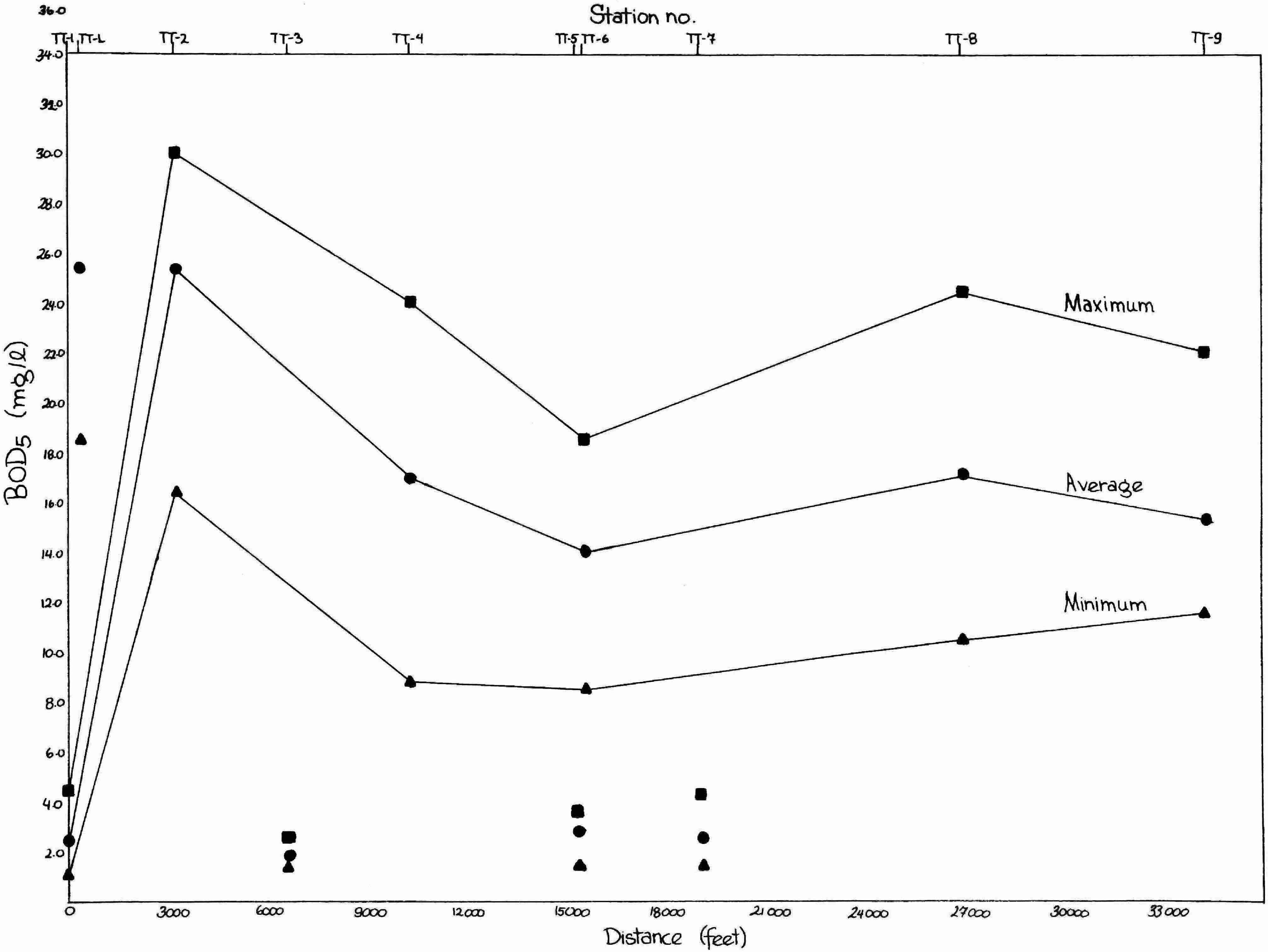

Figure B2 BOD_5 vs. Distance for stations shown on the North Thames River around Tavistock 3-5 May 1977

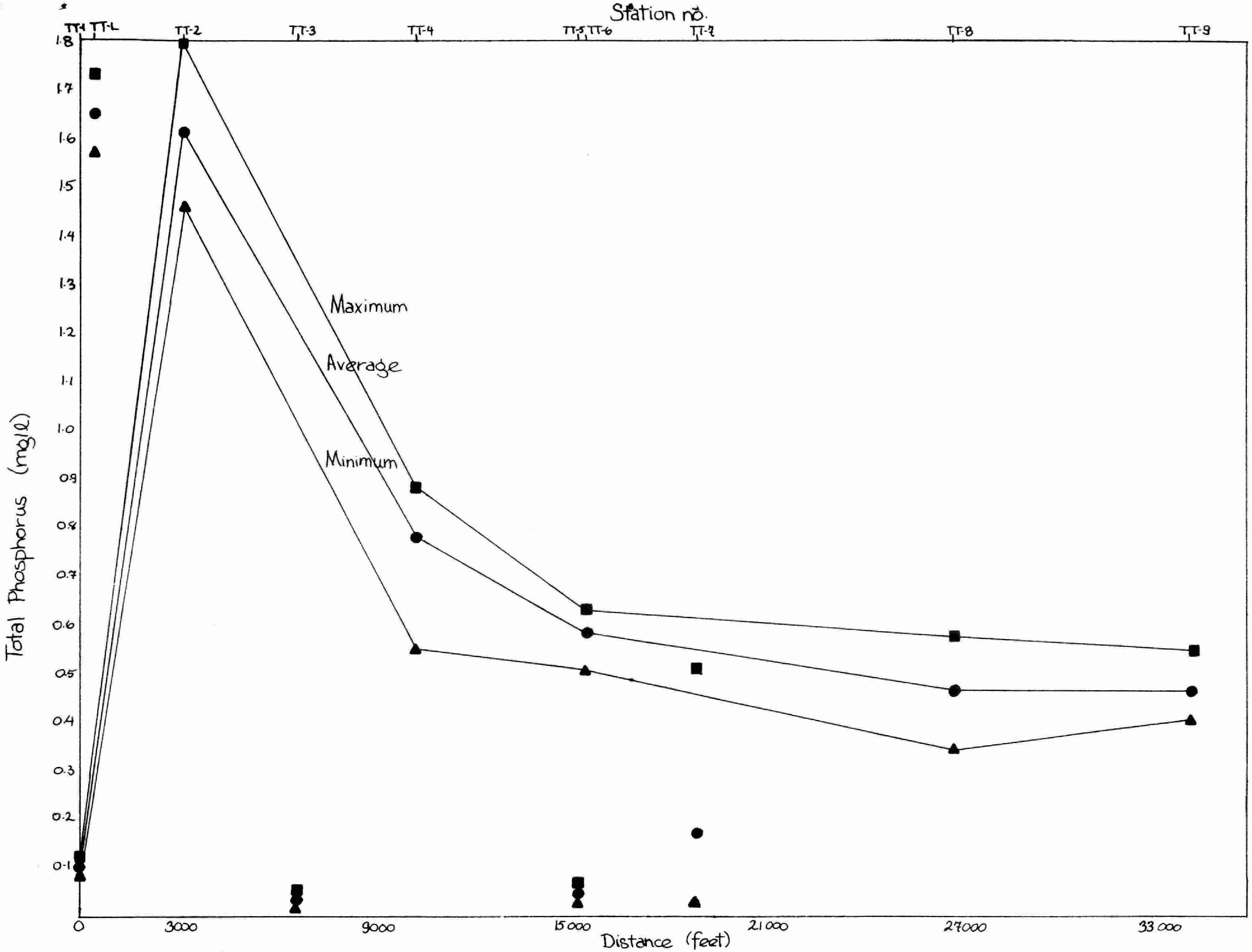

Figure B3 Total Phosphorus vs. Distance for stations shown on the North Thames River around Tavistock 3~5 May 1977

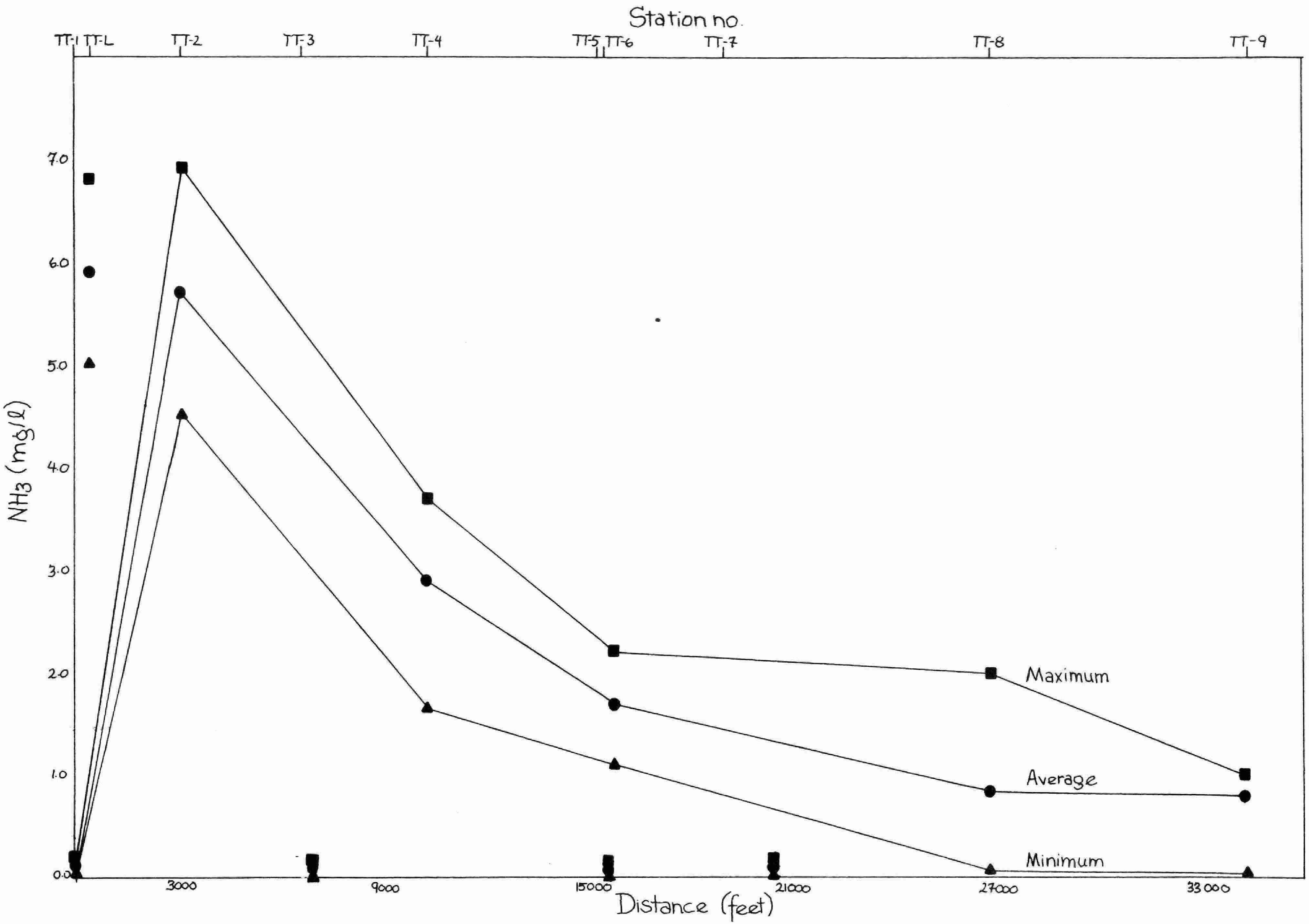

Figure B4 Free NH_3 vs. Distance for stations shown on the North Thames River around Tavistock 3-5 May 1977

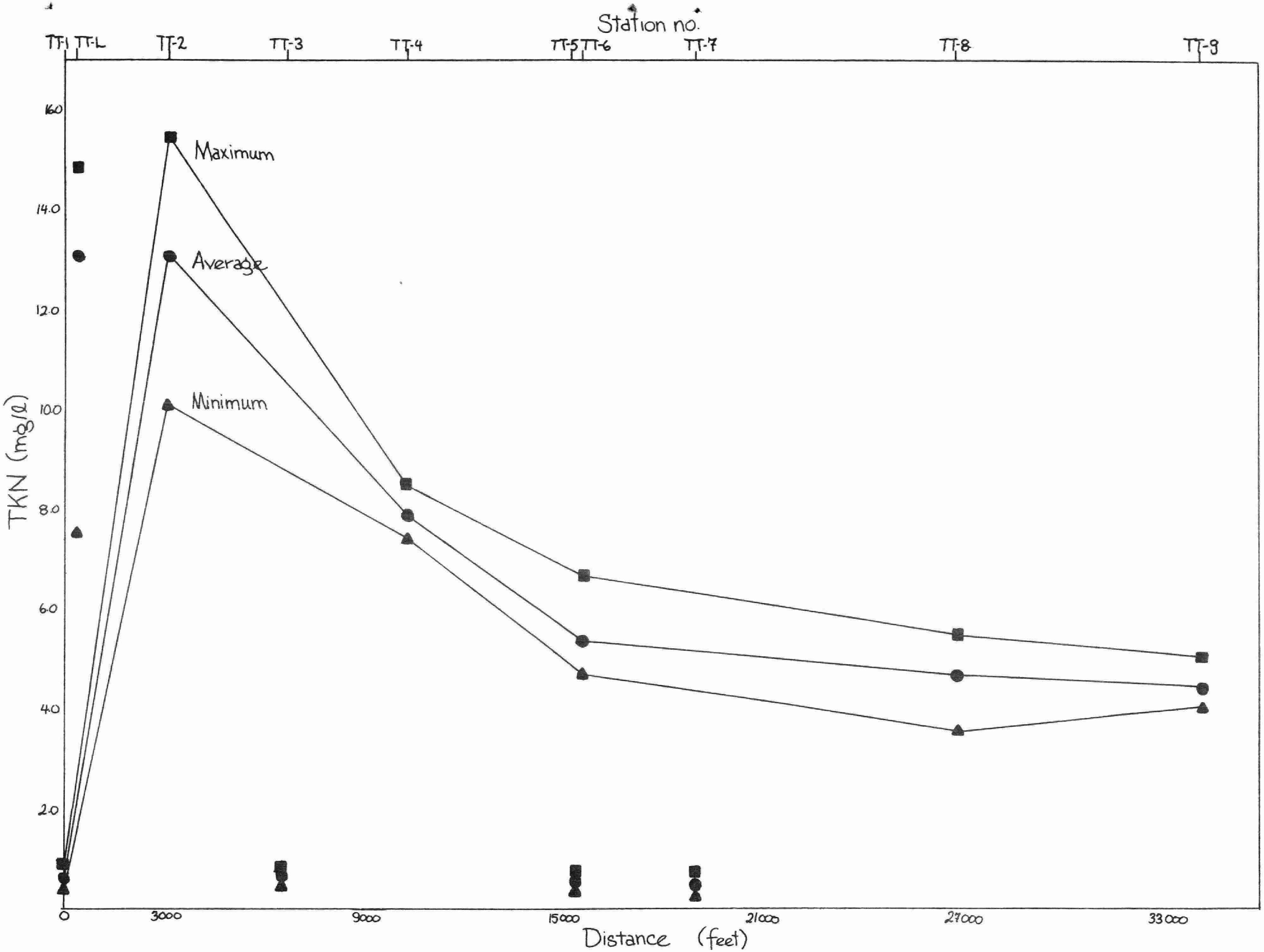

Figure B5 TKN vs. Distance for stations shown on the North Thames River around Tavistock 3-5 May 1977

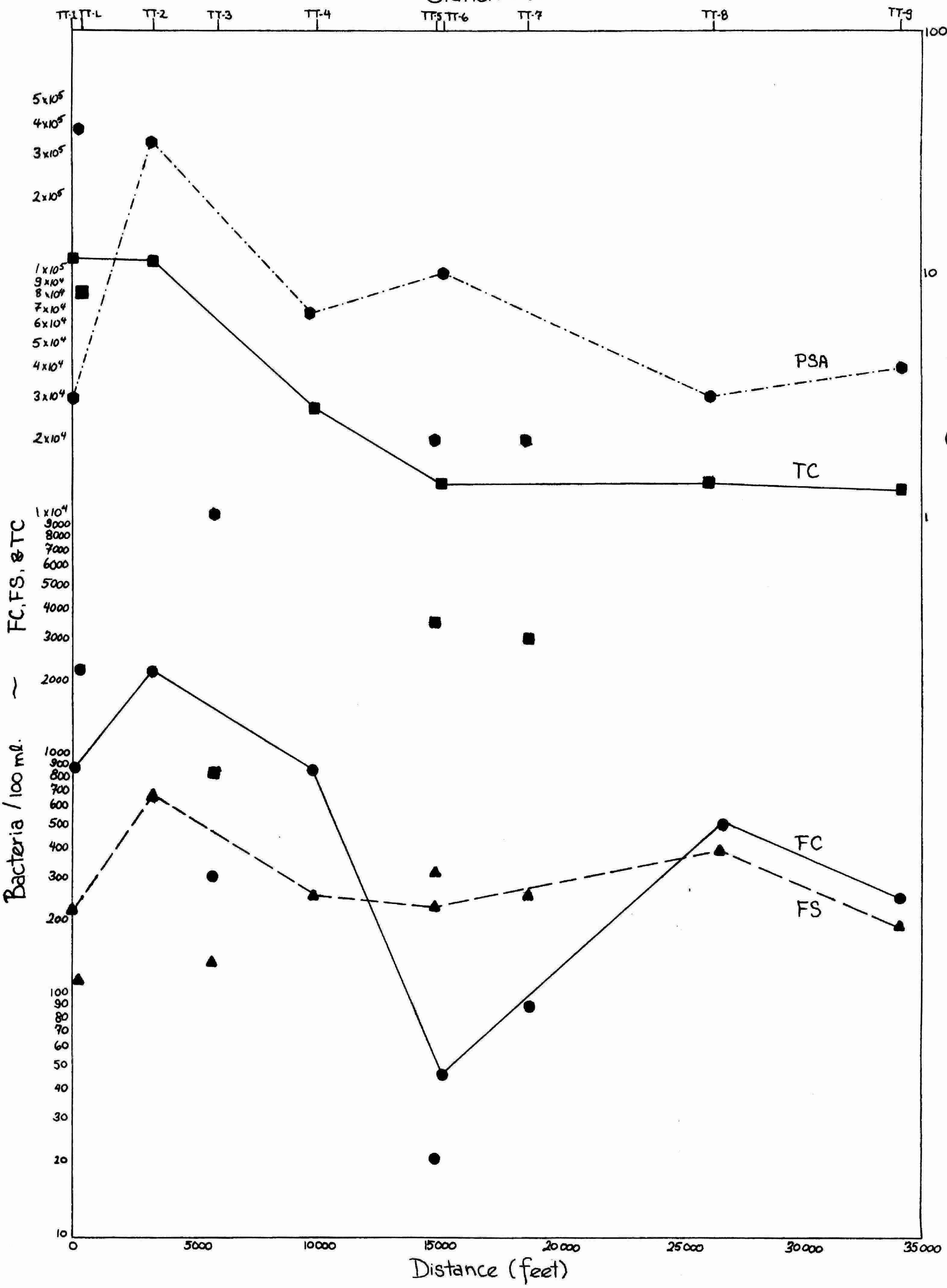

Figure B6 Bacteria vs. Distance for stations shown on the North Thames River around Tavistock 3~5 May 1977